III. Industries of this region.

Why do certain industries obtain in this region?

IV. General forms of land and water, topography, and vegetation on the character and development of people.

1. Influence of continents, islands, seas, lakes, rivers, mountains, and plains on associated peoples. Give examples of each.

2. Special study of the great river valleys which have aided in developing primitive historical people. (a) Nile, Tigro-Euphrates, Indus, Hoangho. What conditions in each specially favored the growth of its respective people? What great geological changes have occurred? Are conditions favorable to primitive development equally potential in advanced civilization?

**References:** *Man and His Work*, Herbertson; *Earth and Its Inhabitants*, Reclus; *Compendiums*, Stanford.

# Mathematics in the High and Pedagogic Schools

George W. Myers

More than a dozen years' class-room experience with mathematical students convinces the writer that the most serious criticism against current methods of teaching elementary mathematics is their utter failure to develop the mathematical sense, to give the student a degree of power to recognize the quantitative aspects of his environment in any way commensurate with the time and thought put upon these subjects. Teachers everywhere, recognizing that serious defects exist in current mathematical pedagogy, seem to be focusing their attention almost entirely upon the attempt to make the meaning of the mathematical processes clearer. In the writer's opinion this is not the main, or even a very serious difficulty. Nor does it appear to him that the lack of analytic power is so serious a matter as some would make it out. The crying need of the mathematical student of our time is the ability to recognize the place and necessity for the use of the numbering function in grappling with his environment. A very limited range of mathematical knowledge, with the power to use it practically, is worth far more to both the student and the world than an unlimited facility in the manipulation of processes without the ability to apply his skill to the concrete world. The ideal mathematician is he who, possessing enough mechanical skill to perform the arithmetical operations with ease, and enough analytic power to enable him to pass readily from the whole to its related parts, perceives with equal ease the abstract in the concrete, and the concrete in the abstract.

## Algebra in the High School

1. Numbers represented by letters.

The representation of generalized number by letters should be taught before the high school. If this has not been done, use the relations between the sides and perimeters, areas, etc., of squares, oblongs, right, equilateral, and isosceles triangles. Draw these figures, cut off their angles, apply them to each other and note whether or not the angles are equal. Designate the angles by letters and represent their sums and differences symbolically.

Illustrative examples:

If a certain line be called $x$, what shall we call twice that line? Five times the line? $a$ times the line? $z$ times the line?

If a man is three times as old as his son and the son is $b$ years old, how old is the man?

2. The use of the symbols $+$, $-$, $\times$ and $\div$ in algebra.

a. They have the same uses as in arithmetic.
b. Their extended uses in algebra.
c. Other ways of representing $\times$ and $\div$.

3. The use of the signs + and — to denote quality in number.

Positive and negative numbers defined.

Illustrated by readings of the thermometer, barometer, graduated circles, latitude, longitude, altitude, azimuth, heat, assets, etc.

The opposition of character implied in all these illustrations, and in all others, may be represented to the eye by selecting a certain point in a horizontal line as an origin, or starting point, and laying off to the right or left, according as the number to be represented is positive or negative, as many linear units as there are units in this number. This gives us a negative series of numbers equal in extent to the ordinary positive series of arithmetic, thereby extending the range of number to double its former compass.

In many algebraic problems two separate and distinct magnitudes must be simultaneously considered and must be kept distinct throughout the discussions. A simple method of doing this is to draw a vertical line through the origin specified above, and to lay off along this vertical, upward or downward, from this origin according as the second magnitude is positive, or negative, as many linear units as there are units in the second magnitude. We then have a simple means of keeping the two different numbers represented separate.

These two numbers are generally denoted by $x$ and $y$. The former is usually measured off along the horizontal, and the latter along the vertical line. Following this convention, we may call the horizontal line the *x-line*, or the *x-axis*; and the vertical, the *y-line*, or the *y-axis*.

4. The equation taught and illustrated.

The meaning of the sign (=) may be taught concretely by the use of the balances in weighing. It should be taught long before the high school in connection with early work in arithmetic. Its value as a tool for the solution of practical problems may and should be shown quite early in the mathematical course.

As early as the grammar school it should be shown experimentally that the sum of all the angles which can be drawn about a point in a plane is 360°, and that the sum of the angles of any triangle is 180°. Elementary astronomical work will show the need of such subdivision.

Draw an equilateral triangle, cut off the corners (angles) and apply them to each other. Denote the magnitude of one of the angles by $x$. What will denote the sum of all three? This sum being also 180°, we may write,

$$3x = 180°.$$

What then is the value in degrees of one of the angles of the equilateral triangle?

Draw an isosceles right triangle and denote one side by $x$ and the hypotenuse by $y$. What is the perimeter? The area? Measure the sides and express the perimeter in inches. Write an equation between your two numbers representing the perimeter. What is the area of the triangle? If the triangle has been drawn on cross-ruled paper, count the number of square inches or square tenths of inches. Write an equation between your two values for the area. Can you find the value of $y$?

This latter problem shows how two unknown numbers may enter a problem; for suppose it were required to find the sides of such a triangle whose perimeter is to be 13 inches and whose area must be 8. The equations would then be:

$$2x + y = 13, \text{ and } \frac{x^2}{2} = 8, \text{ or } x^2 = 16.$$

5. The equation represented graphically.

In plotting the values of $x$ and $y$ it is not necessary to lay them off on the respective axes. It is obvious that $y$-values may be laid off parallel to the $y$-axis from the *x-axis*.

One of the fundamental laws of motion is symbolized by $f=mx$, $f$, force, $m$, mass, and $x$, acceleration.

For uniform motion we have $S=Vt$, where S denotes the space described, V the velocity, and t, the time.

In the theory of stresses and strains we have $P=AS$ and $e=ls$. Explain symbols.

For the pressure in pipes and cylinders we have $P=pld$. Explain meaning of symbols.

These formulas are typical of the fundamental relations of mechanics of materials and they will be derived and studied for their use in the study of woods, irons, etc.

Let it be noted that they are all (under certain conditions) of the form $y=kx$. Let us study this equation, first in a simpler form; viz.: $y=x$. Plot it.

We shall then study $y=2x$, $y=5x$ and $y=kx$.

Now apply what has been learned to the foregoing practical equations.

Many more general equations will then be plotted and studied graphically, until such equations are understood algebraically and interpreted mechanically and geometrically.

6. The effect of the + and — signs as symbols of operation when followed by the same signs as symbols of quality interpreted graphically.

## Pedagogic School

Eighth Grade, Mathematics. In general the work in mathematics of the seventh and eighth grades should be substantially the same in kind and should undertake to secure two different, though related, ideals in education:

I. A connected and comprehensive view of the fundamental facts of arithmetic together with some degree of facility in generalizing from these facts to principles. Such work as this should be begun earlier than here, but it should receive much greater emphasis here than at any earlier stage. The need of a reasonable insistence upon accuracy begins to be felt by the pupil of these grades.

II. Some insight into the subject-matter and methods of the higher mathematics together with a degree of ability on the pupil's part to form a comparative estimate of the merits of the methods of geometry, algebra and trigonometry and those of arithmetic. Pupils may thus be led to see that these higher branches of mathematics should be studied because they furnish easier and more direct means of waging "the conquest of nature" in time and space than does arithmetic. This gives the young pupil an objective, rather than a subjective, reason for the study of these advanced subjects and reasons of the former sort appeal to him much more strongly at this stage of study than do those of the latter sort, such as mental discipline, educative value, etc.

Percentage, Interest, etc., may well be given attention here, though they should be introduced and taught in closest connection with fractions at an earlier stage. The main reason for taking them up here again is that they furnish so many excellent opportunities for generalizing to the broader principles of algebra. In all the work of these grades the pupil should be taught to study the conditions of his problem and to decide what is the simplest course to pursue, for the simplest is always the best—to think his problem out—before he sets about the mechanical work of executing the solution.

Subject-matter. The first of these ideals is best realized through the facts of science, geography, sociology, manual training and physical training which teachers and pupils have been gathering and are still gathering at this time.

The work in science will consist of discussions of data furnished by the rain-gauge, the thermometer, barometer, hygrometer, the skiameter and other appliances, most of which will be made by the pupils. The discussions will lay a reasonable stress on accuracy and rapidity of

calculation and will insist everywhere on intelligent interpretation of results.

In geography, such questions should be studied as the fall of rivers, lengths of rivers, extent of river basins, areas of continents and countries, lengths of coast lines, carrying power of rivers and winds, percentage of water soaking into the soil after rains, influences of the tides, tides in rivers, rate of motion of free and forced waves in ocean, heat absorbed by atmosphere, variations of heat due to changing obliquity of rays, dependence of obliquity of rays upon the latitude, cause of seasons, the reason why the time of highest temperature is not coincident with the time of greatest obliquity of solar rays. Seasons on other planets.

In the study of the community life of man, or sociology, the arts and industries, the food supply of the race, the agencies of commerce, transportation, navigation, and general distribution of the products of labor will open up a vast field for mathematical work.

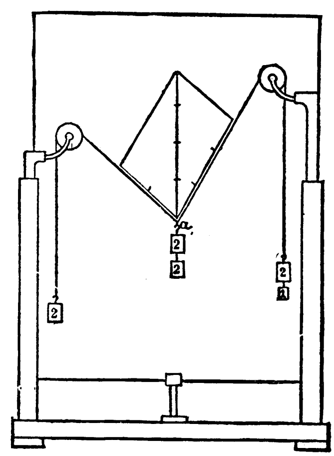
In the manual training department all apparatus will be made in accordance with definite specifications, which must be discussed with reference to the purpose in view by the class and decided upon before beginning, Here it will be clearly seen that mathematical accuracy can never be realized in practice, and that absolute, uncompromising accuracy is important only to the abstract logician. To the individual who expects to use his mathematics it is necessary only that he work safely within practically attainable limits. It needs to be borne in mind that it is sometimes as unmathematical to insist on absolute accuracy as it is to ignore accuracy entirely, unless mathematics be identified with logic.

The measures taken in physical training will be largely used as bases of practical deductions as to the care of the body, the proper kind and amount of training and exercise for each individual and as to the true meaning of proportion and symmetry in regard to the human form.

The second aim suggested above will be worked out through a study of the forces which are continually operative in the environment of the pupil and which he has already begun to feel a desire to understand more fully.

A. Forces acting on a free point.

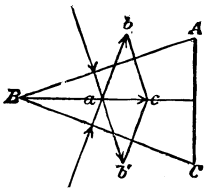
By the aid of an apparatus such as is represented in the accompanying cut, which may be

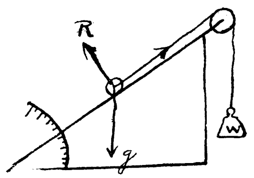



made in the manual training shop, the principle known as the parallelogram of forces may be worked out experimentally. A smooth ring, or small pulley at *a*, will be held at rest, or in equilibrium, when the weights are such that the one at *a* is represented by the diagonal of a parallelogram of which the lengths of the sides represent the side weights. When *a* is at rest lines may be drawn along the cords on a sheet of paper pinned on the board just behind the weights. On these lines lay off lengths to represent the side forces, or weights, and complete the parallelogram. Does the measured length of the diagonal of this parallelogram represent the weight at *a*? Repeat the experiment with different weights at the sides, varying the weight at *a* so as to produce equilibrium. A horizontal board or a table with pulleys at the edges may be used instead of the appa-

ratus here suggested. Extend principle to "polygon of forces."

Show how this principle applies to each of the simple machines—inclined plane, wedge,

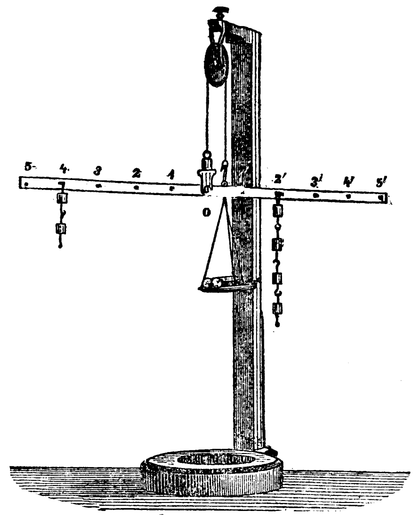



etc. Devise an apparatus for applying weight parallel to base.

B. Forces acting on a free body.

With apparatus like the one here suggested study the action of parallel forces on a body. This brings up the question of moments and the apparatus furnishes a means of studying it experimentally. How is the light thus obtained of value in studying the stability of trees and structures against being overturned by the wind and other forces? This leads to a necessity of studying the center of gravity, which will be taken up next month. Considerable field



work in elementary geometry should be done in this grade.

# Home Economics

## Alice Peloubet Norton

The study of the home and its management finds its justification as part of the school work in the importance of the home as a social factor, in the influence of the home upon character, and in the fact that nearly all the sciences find direct application in home life. The subject in its broadest interpretation embraces the study of the home itself, its evolution, its function, and its relation to other social institutions; the discussion of the problems of the family, including the training of children; the consideration of the house, its relation to the home, its architecture and decoration, and the sanitary conditions which affect the welfare of its inmates. It deals with the whole great food problem from the standpoint of economics, the production of human energy, and the "labor power of nations." The composition, source, and nutritive value of food materials, their chemical analysis, the detection of adulterations, and the calculation of dietaries belong to the subject as legitimately as do the cooking and serving of food.

Clothing in its historical, hygienic, and æsthetic aspects, household expenditure, and the division of the income all find a place in this science of the home.

The purpose of the work offered in this department is twofold. It aims, first, to show to the student the importance of the home and its work, and to arouse interest by giving familiarity with its common processes and their underlying prin-